Invited series of talks and lectures at Yale University (USA) on Rolf Nordahl's research

Presentation of Rolf Nordahls research on Presence and the "Natural Interactive Walking" project (FET OPEN, FP7)

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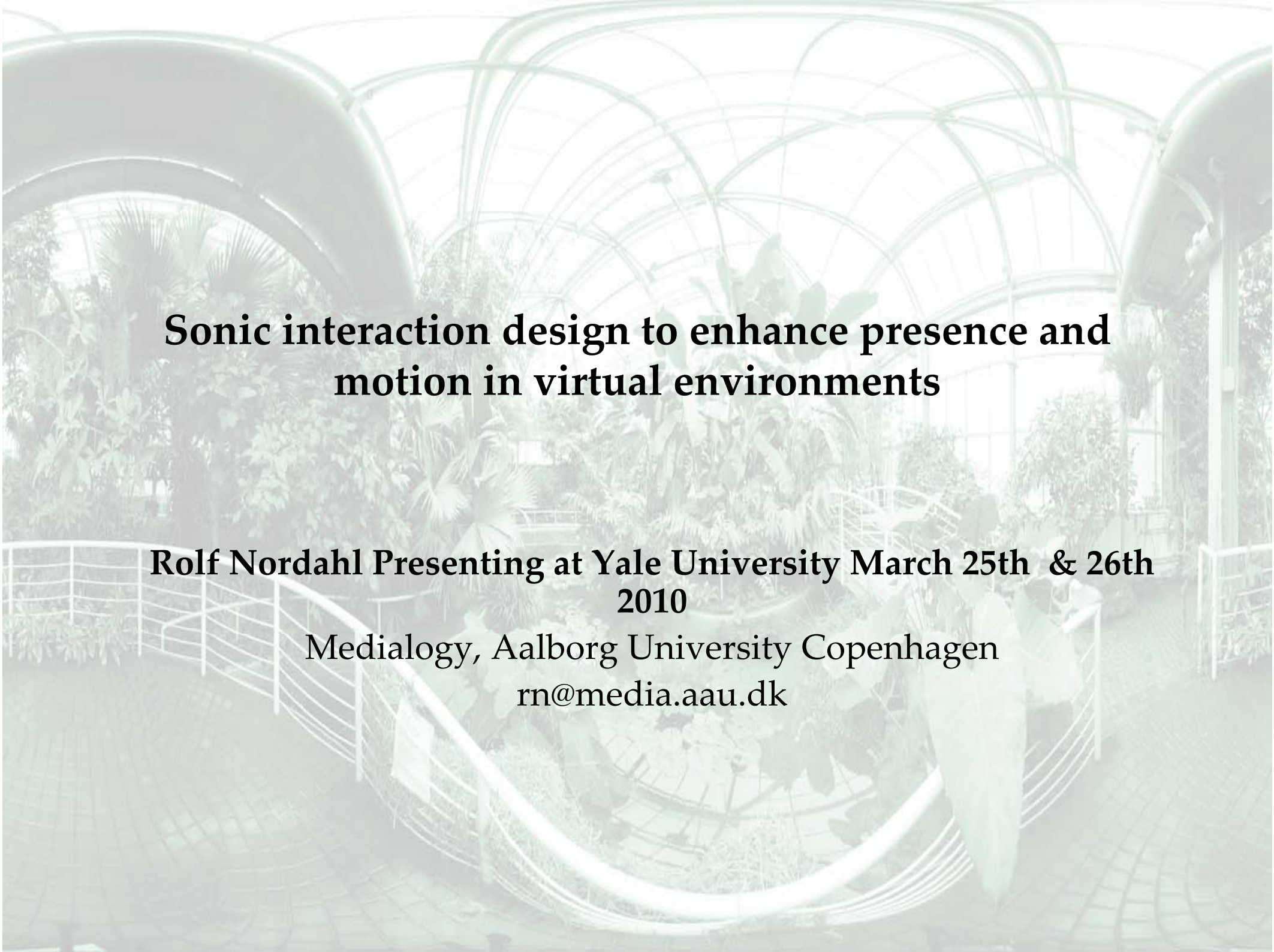

Sonic interaction design to enhance presence and motion in virtual environments

Rolf Nordahl Presenting at Yale University March 25th & 26th 2010

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Overview

- Motivation
- Experimental Design
- Results
- Future Directions

Motivation

Problem: While subjects appreciate the visual quality of experiencing Image Based Rendering techniques, dynamic events were missing which perhaps lead to a smaller amount of movement.

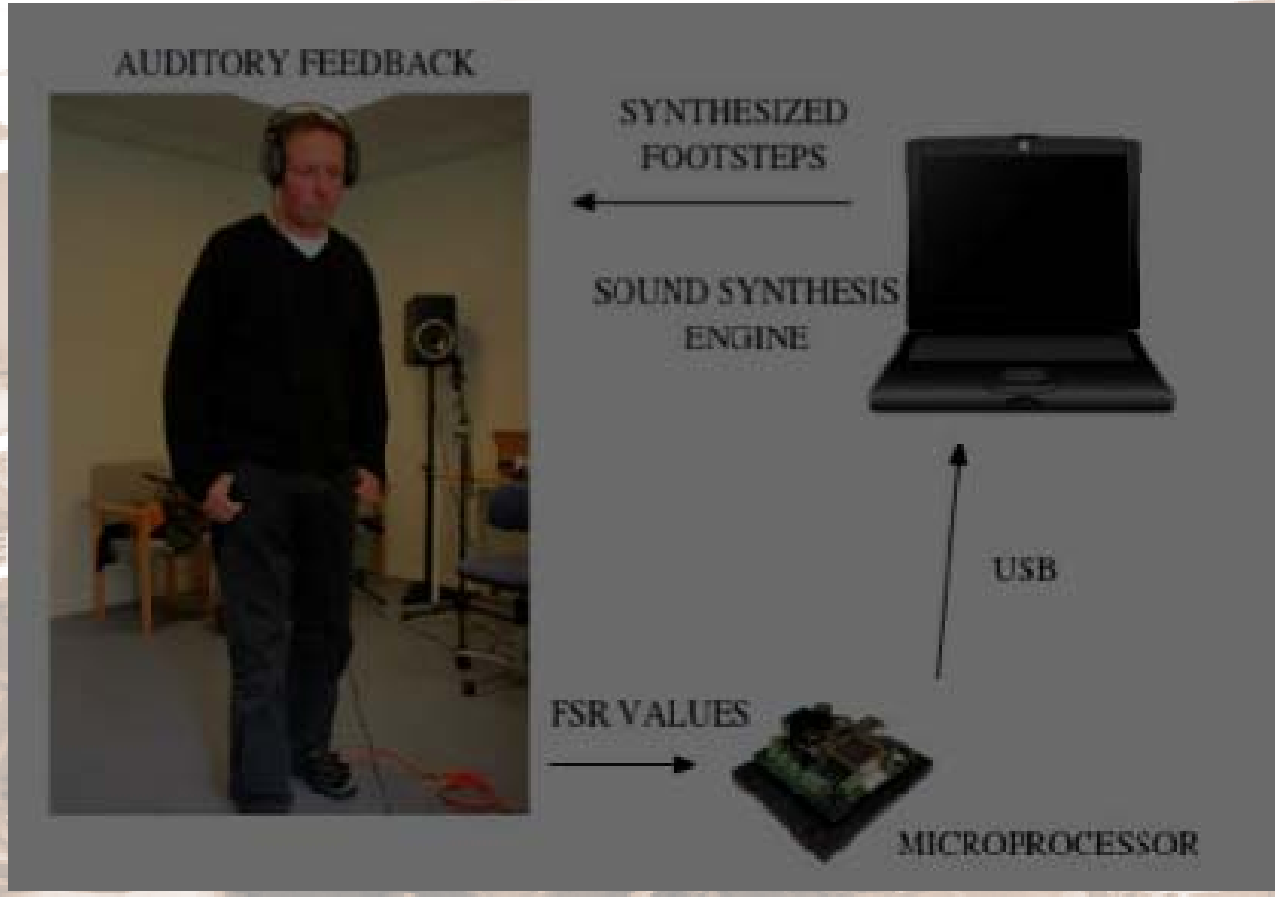
Through previous research we have experimented with:

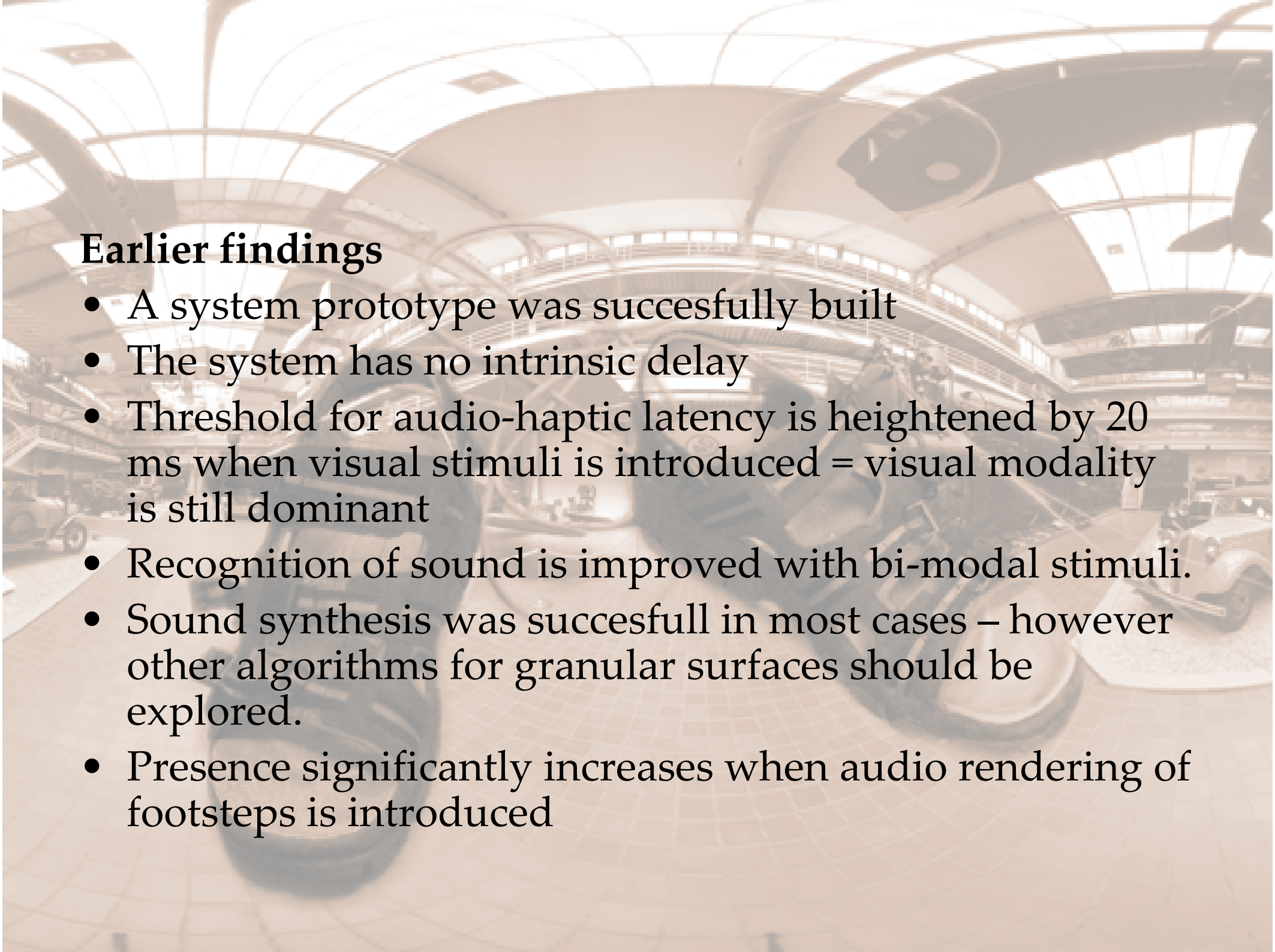
a. Static Sound Design (8 – Channel): Role of soundscapes in photorealistic environments

b. Experiments with rendering acoustics for self movement without any additional sounds.

Shoes and sensors

- Pressure sensitive shoes
- Realtime rendering of one's own footsteps
- Wired solution





Earlier findings

- A system prototype was succesfully built
- The system has no intrinsic delay
- Threshold for audio-haptic latency is heightened by 20 ms when visual stimuli is introduced = visual modality is still dominant
- Recognition of sound is improved with bi-modal stimuli.
- Sound synthesis was succesfull in most cases – however other algorithms for granular surfaces should be explored.
- Presence significantly increases when audio rendering of footsteps is introduced

Goals

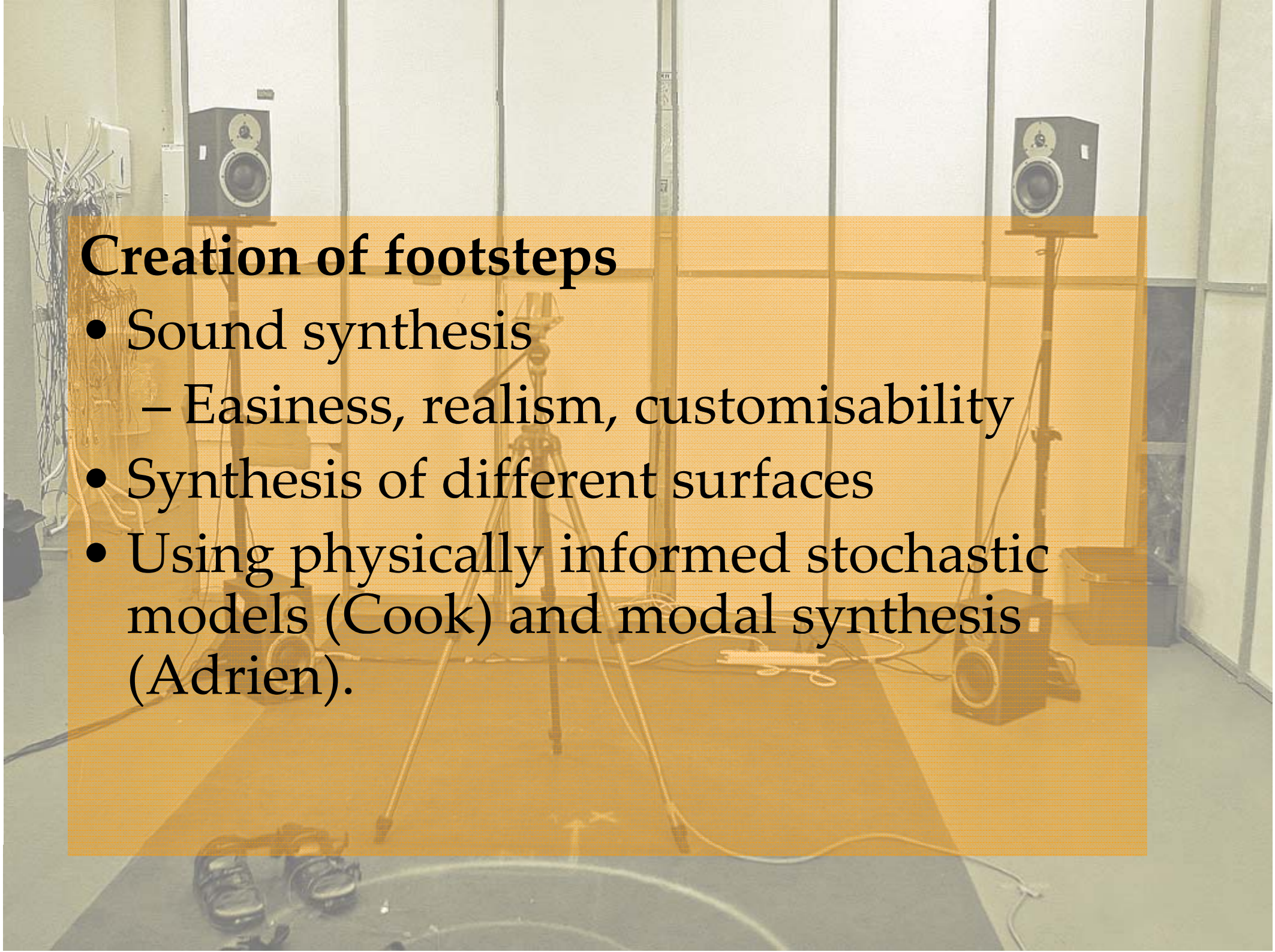
To understand how different kinds of sound designs affect the subject's motion and perceived feeling of presence.

Experiments with both self sounds and soundscapes

Wish to understand if sound helps to increase the motion of subjects

Wired Shoes

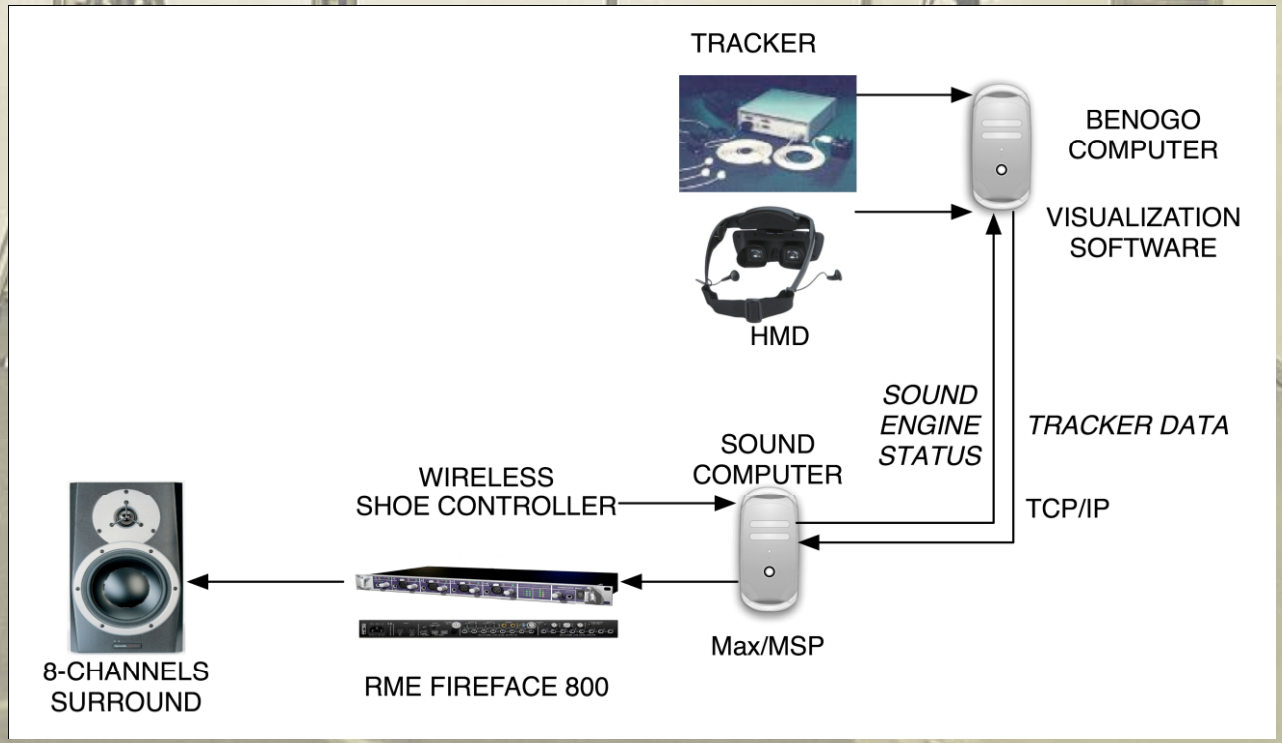
Wireless Shoes



Creation of footsteps

- Sound synthesis
  - Easiness, realism, customisability
- Synthesis of different surfaces
- Using physically informed stochastic models (Cook) and modal synthesis (Adrien).

- Visuals delivered by Image Based Rendering method (BENOGO)
- 3D Audio delivered through 8 channel speaker system



Experimental Design

Auditory stimuli

- Prerendered soundscape
- Dynamic moving sound sources (3D)
- Footstep synthesis

126 tests were run succesfully and were divided as follows to the 6 conditions

Experimental Conditions in Laboratory

Full	= 21 subjects
Full sequenced	= 21 subjects
Visual Only	= 21 subjects
Music	= 21 subjects
Visual w. footsteps	= 21 subjects
Sound + 3D	= 21 subjects

Visual feedback

Benogo botanical garden

Results

Tracked movement	Full	Music	Full Seq	Visuals only	Visuals w. footsteps	Sound + 3D
Mean	26,47	20,95	25,19	21,41	22,82	21,77
Median	26,54	20,79	24,31	21,61	25,66	21,87
st.d.	5,6	6,38	5,91	6,39	6,89	6,74

Euclidian distance over time (180 secs)

Results

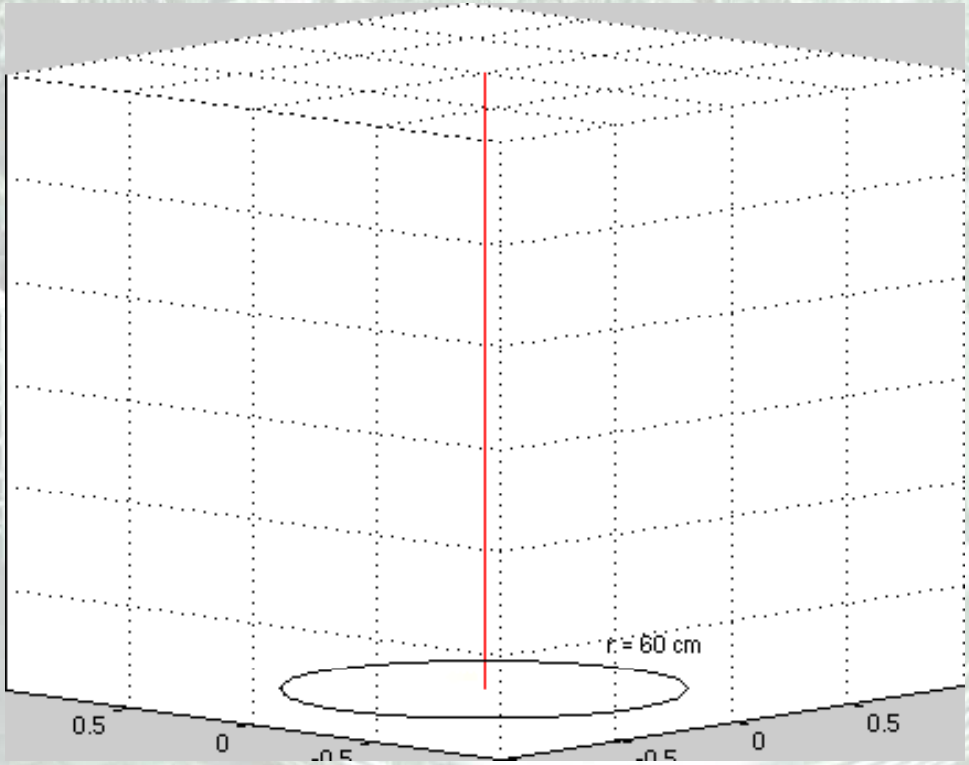
	Full	Music	Full seq.	Visual only	Visual w. foot	Sound + 3D
Full						
Music	0.003					
Full seq.	0.243	0.018				
Visual Only	0.006	0.41	0.03			
Visual w. foot	0.04	0.197	0.132	0.26		
Sound + 3D	0.011	0.347	0.048	0.431	0.32	

Experimental Design

The movements of the subjects are tracked.

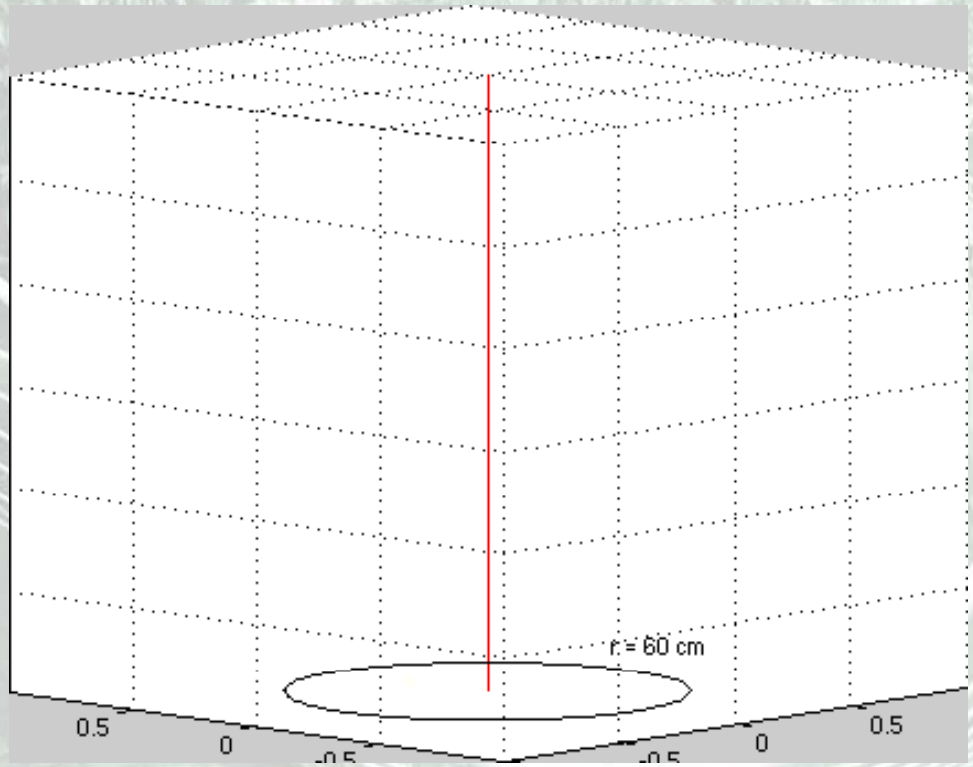
We have created 2D visualizations of this movement over time.

Here is a video-clip that shows the movement of a subject in the condition ”Visuals Only”.



Experimental Design

Here is a video-clip that shows the movement of a subject in the condition ”Full Sequenced”.



Results

Better understanding of the role of sound in Ve's:

- **Auditory rendering of ego-motion**
- **Soundscapes**
- **3D Sound**

It is interesting that it is the **combination of the 3 different sound-conditions** that give **the best result in terms of motion.**

However, there are **clear significant indications** that the **auditory rendering of Ego-motion plays a important role in motivating movement.**

Future Directions

Dynamic creation of soundscapes, e.g. using adaptive techniques.

Possibility to render impact sounds, especially when users grab objects.

Investigation on whether these results may be transferable to other media-types (Games, Mobile Devices, 3D animated environments).